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Thus three important points are accomplished: the light is thrown in the best direction and manner on the divisions; all other light is excluded; and the heat of the lamp is prevented from expanding the sextant to which it is attached only for the time required to make an observation, which rarely exceeds one minute.

No. XIII.

APPARATUS FOR MAKING SHIP'S BISCUITS.

The LARGE GOLD MEDAL *was voted to* THOMAS TASSELL GRANT, *Esq., of Weovil, near Portsmouth, for his improved Apparatus for the Manufacture of Ship's Biscuits.*

THE advantages claimed for the new over the old method of preparing ship's biscuit are, superior economy and expedition, greater cleanliness in the process, and a better quality in the manufactured article.

The mode of making ship's biscuit, as practised in the King's bakehouse at Portsmouth, was as follows:—

Five men were appointed to the service of each of the nine ovens, being forty-five in the whole.

The first of these was the idleman, whose business was to mix the meal and water in due proportions, and to incorporate the materials as accurately as possible by kneading the dough for half an hour, with his naked arms plunged into it up to the elbows, and finishing the operation by jumping into the trough and treading the dough with his feet. Hence it passed to the brakeman, who completed the kneading by means of a lever, on which he pressed with his whole weight, this part of the process being called riding down the dough.

It then passed into the hands of the furner, who first divided the dough into lumps somewhat bigger than an egg, and passed them on to his mate, who pressed and moulded each by hand into the form of a biscuit, and finished by pricking them with an iron instrument, to prevent blisters from rising in the dough during baking.

The biscuits being thus formed, were supplied in succession to the pitcher, who threw each on the peel of the furner as soon as he had deposited the previous one in its proper place in the oven. Each oven was capable of holding 450 biscuits, weighing together one hundred weight; and two charges, that is 900 biscuits, were baked in an hour.

The above-described process, besides the general slovenliness of it, was liable to the two following disadvantages:—

It was not possible for the idleman and brakeman, with all their care, to effect a perfect and uniform mixture of the flour with the water; the consequence of which was, that the wetter portions detained some of the water till it was boiling hot, and in that state reacted on the starch of the flour, so as to give the biscuit, when dry, a glossy fracture and almost stony hardness.

Neither could the furner divide the mass of dough into lumps of perfectly equal size, in consequence of which, the biscuits being of various thickness, the thinner ones were scorched in the baking, and the thicker ones were underbaked, so that they soon became mouldy in the close, warm air of a ship's bread-room.

In Mr. Grant's apparatus, the greater part of the labour is performed by steam-power: the nine ovens are heated by one continuous fire-place, the flame of which is admitted by means of a register into each oven as soon as the previous charge has been withdrawn, and in five minutes brings it to a sufficient heat. It takes fourteen or fifteen minutes to bake each charge, so that three charges can be worked off in one hour, being an advantage in point of expedition of one-half more than by the old method.

This apparatus was first erected at Weovil, near Portsmouth, in the year 1832, under the immediate superintendence of Sir John Rennie, and has continued at work successfully up to the present time. It has since been adopted, with certain modifications, at the bakehouse of Messrs. Fraser and Hullah, of Wapping, who have kindly permitted the Society to inspect it, and to take the requisite observations for preparing the following sketches and description, by which it is hoped that it will be rendered generally intelligible.

The first machine is the mixer, of which fig. 1 is an

Fig. 1.

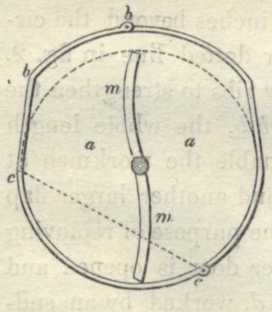
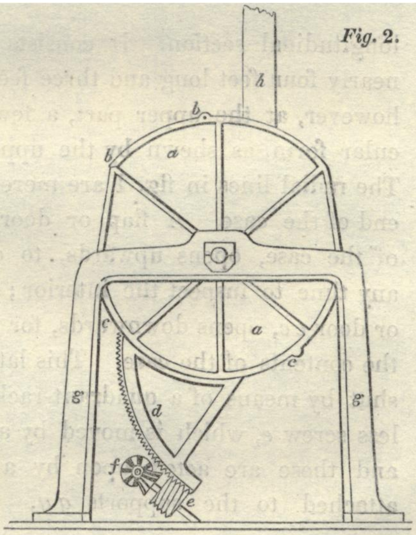
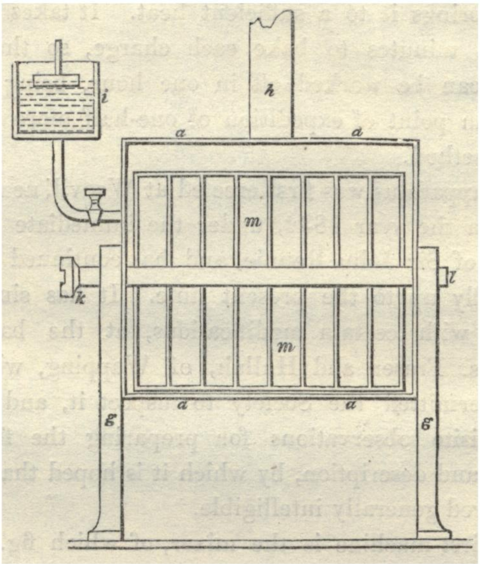


Fig. 2.



end elevation, fig. 2 a transverse section, and fig. 3 a

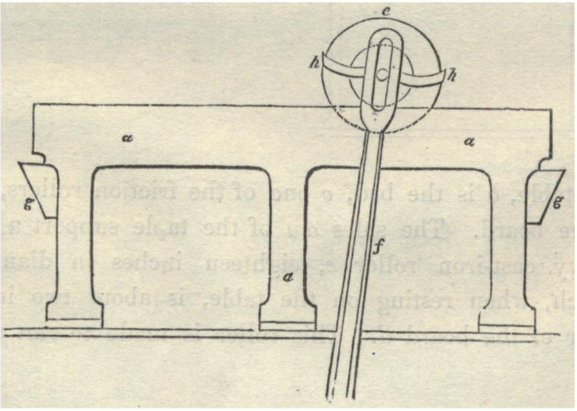
Fig. 3.



longitudinal section. It consists of a cast-iron case *a a*, nearly four feet long and three feet in diameter, enlarged, however, at the upper part, a few inches beyond the circular form, as shewn by the upper dotted line in fig. 2. The radial lines in fig. 1 are merely ribs to strengthen the end of the case. A flap or door *b b*, the whole length of the case, opens upwards, to enable the workmen at any time to inspect the interior; and another larger flap or door *c c*, opens downwards, for the purpose of removing the contents of the case. This latter door is opened and shut by means of a quadrant-rack *d*, worked by an endless screw *e*, which is moved by a pair of bevel pinions *f*, and these are acted upon by a small winch and axle attached to the supports *g g*. The operation of this machine is as follows:—The requisite quantity of flour is sent down from the loft above by the shoot *h*, and the proper quantity of water is supplied from the small cistern *i*, which has a float and gauge, with a line and pulley, to indicate the quantity admitted from a larger cistern above, and a pipe and cock to convey the water into the case. The flour and water being admitted, the central axle, or shaft *k l*, is put into gear with the steam-engine by means of the coupling-box *k*; the axis is thus made to revolve very rapidly, carrying around with it the frame of eighteen knives or mixers *m m*. These knives, which are curved, as shewn in fig. 2, are two inches wide, and three-eighths of an inch thick at the back; they are connected at their extremities by similar longitudinal knives, which, in revolving, almost touch the lower part of the case. By these means it is evident that the flour and water must in a short time become thoroughly mixed. The paste is then removed by hand through the door *c c*, and placed upon a table, which is as close as convenient to the mixer, and which is now to be described.

This table is shewn in an elevation fig. 4, plan fig. 5,

Fig. 4.



and transverse section fig. 6. It has a cast-iron frame and legs *a a a,* a cast-iron bed *b b* (six feet and a half long and three feet wide), in which are the six holes *c c,* &c. to receive friction-rollers, on which run the boards to receive the dough. Fig. 7 is an enlarged section of the side *a* of the table, *b* is the bed, *c* one of the friction rollers, and *d* the board. The sides *a a* of the table support a very heavy cast-iron roller *e,* eighteen inches in diameter, which, when resting on the table, is about two inches clear of the board *d.* This roller is made to run alter-

Fig. 5.

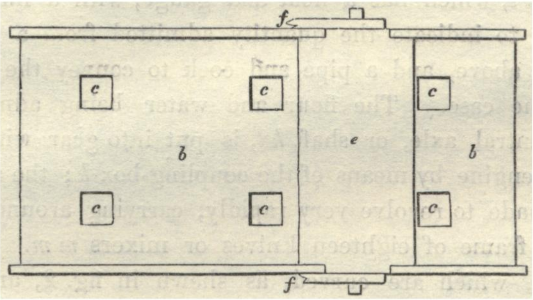


Fig. 6.

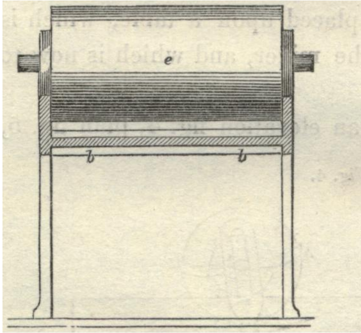
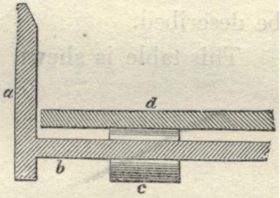


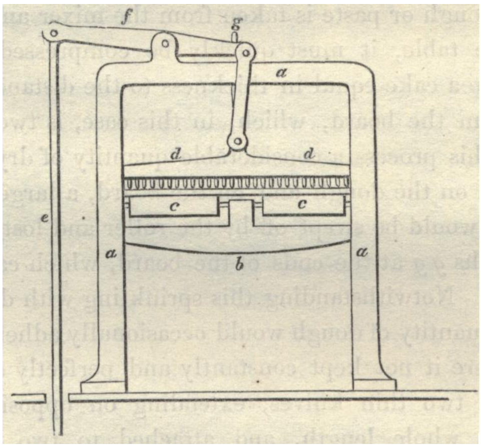
Fig. 7.



nately, and with great rapidity, from one end of the table to the other, by means of a pair of beams ten or eleven feet long, attached to centres below the floor under the middle of the table, and made to alternate by a crank from the steam-engine; the upper end of one of these beams is seen at *f*, fig. 4, shewing the groove in its extremity to allow the axis of the roller to play in it as the beam alternates. It will now be evident, that when a mass of dough or paste is taken from the mixer and placed upon the table, it must quickly be compressed by the roller into a cake equal in thickness to the distance of the roller from the board, which, in this case, is two inches. During this process a considerable quantity of dry flour is sprinkled on the dough and on the board, a large portion of which would be swept off by the roller and lost, but for the troughs *g g* at the ends of the board, which catch and retain it. Notwithstanding this sprinkling with dry flour, a small quantity of dough would occasionally adhere to the roller, were it not kept constantly and perfectly clean by means of two thin knives, extending on opposite sides along its whole length, and attached to two pairs of curved arms, one pair of which, *h h*, is seen fixed to the beam *f*. When this operation is finished, the board with the dough is withdrawn, and another board introduced, on which the process is repeated. The first board and dough being withdrawn, are conveyed, on a series of friction-rollers, to a second table precisely similar to that just described, except that the roller approaches to the board within such a distance as is required for the thickness of the biscuit. The dough, which was reduced to a cake two inches thick at the first table, is cut into pieces and laid in portions on the second table, where it is quickly brought down to the proper thickness for biscuits. The board containing this comparatively thin sheet of dough is pushed forward, still running on friction-rollers, towards a machine next to be described, while the workmen at the second table repeat their operations on the fresh portions of the dough which they have received from the first.

The machine, towards which the board and sheet of dough now rolls, is shewn in fig. 8: it consists of a strong

Fig. 8.



cast-iron frame *aaa*, with cross-beams *b* supporting three or more pairs of rollers *cc*, on to which the board is pushed. Immediately above is a thick plate of cast-iron *dd*, three feet square, which is made to ascend and descend alternately by an excentric, which acts on the rod *e*, the lever *f*, and the guide-rod *g*. The iron-plate *d*, is shewn in the figure at its lowest position; it is, of course, at its highest when the dough and board are brought under it. When this is done it descends and cuts the dough into hexagonal pieces or biscuits by means of thin knives, one inch wide, affixed to its under surface, and arranged so as to form hexagonal spaces. A small part of the under side of the plate *dd,* is shewn on a larger scale in fig. 9, where, in addition to a portion of the hexagonal knives or cutters, will be seen a number of small dots or circles, which indicate the pins or prickers to give the requisite punctures to the biscuits before they are baked. These pins are as long as the depth of the hexagonal cutters; that is to say, one inch; they are about one-third of an inch in diameter, and pointed at their extremities. The effect of all these cutters and pins would, however, be to cause the plate *d* to cling to, and lift with it, the sheet of dough. In order to prevent this a very ingenious contrivance is introduced; a part of which will have been observed in fig. 9. In each hexagon will be seen three arms branching from the centre. These are formed of iron, and each set is connected with a small vertical iron stem, which passes through the plate *d*, moving easily, and is surmounted by an iron ball, two inches in diameter, acting as a weight to press the stem and the arms downwards. One of these balls, with its stem and arms, and a portion of the plate *dd,* is shewn in fig. 10, where *aaa* are the three arms, *b* the stem, *c* the ball, *ff* a portion of the dough, and *gg* a part of the board beneath. It will easily be understood that when the plate *dd* rises, the stem *b* will drop through its hole, pressed by the ball *c*, and, acting on the dough by the arms *aaa*, will disengage it from the hold of the prickers and cutters. When the plate *dd* descends to cut the dough, of course the arms *aaa* rise up to the plate, and the stem rises upwards in its hole, carrying

Fig. 9.

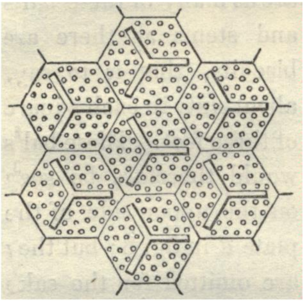
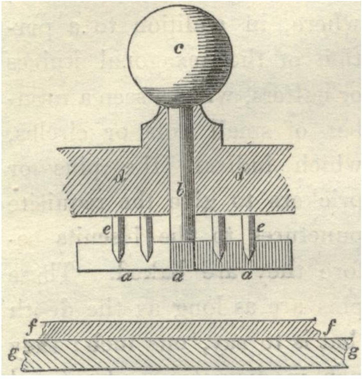


Fig. 10.



with it the ball. There are as many of these balls and stems as there are biscuits, that is to say, about sixty in each square of three feet. These balls would therefore be seen on the upper side of the plate *d* in fig. 8; but they are omitted for the sake of avoiding confusion.

The hexagonal cutters do not so completely separate the sheet of dough as to prevent its being put whole into the oven, into which it is introduced by being laid on a plate of iron, which fits on to the handle of the peel by a bayonet-joint. The sheet of dough, when baked, is broken into biscuits, which take the form marked out by the cutters.

The arrangement of the several machines would, in some measure, depend on the form of the building and other circumstances. They should be as near together as is convenient, in order that the boards may pass from one to the other on rollers; the mixing-machine should be near the supply of water and flour; and the cutting-machine should, of course, be near the oven. A series of rollers should be fixed against the wall, for the purpose of returning the boards to the first table after they have been emptied. At Portsmouth, this series of rollers was kept constantly revolving by the steam-engine, so that when the empty boards were placed upon any part of the line, they travelled up to the mixer without further attention.

CORRIGENDA IN FIRST PART OF VOL. L.

Page 11, 5 *lines from bottom*, *for* height, and place the connecting bar *g*, *read* height and place, the connecting bar *g*.
13, *line* 2, *for* ; then unclamp *read* , first unclamping.
14, 5 and 8, *for b read l.*
— 16, *for* lie *read* lies the bar.
26, 8, *after* grs. *add* of morphia.
33, 16, *dele* working.
39, 3, *for* latter *read* former.
— 10, *after* to *add* air and.
53, 8, 11, 27, 31, *for* bar or bars *read* arm or arms.
— 14, *for* 2 *read* 1.
55, 21, *dele* subsequently.
57, 14, *dele* and.
58, 3 *from bottom, for c c,* which is a front, *read* which is a front view, *c c.*
59, 5 *from bottom*, *dele* thrown back and, *and insert the same in the next following line*, *after* compartment.
63, 5, *for* covered *read* high-pressure.
69, 5 *from bottom*, *for* right angles *read* the angle.
84, 9, *after* horns *insert e.*
86, 12 *from bottom*, *dele* (as in figure 15).
90, 1 *and* 2, *omit* alternate.
— 6, *omit* half the planks retain their original thickness, and.
— 9, *omit* half.
91, 6 *from bottom*, *after* separate *add* in perspective.
—, *last line*, *after* Fig. 1 *add* the two other arms of this knee are horizontal, and at right angles to each other, one of them being parallel to the side of the ship, and the other perpendicular to it.
99, *last line*, *for* 1 *read* 2.
100, *line* 1, *for* 2 *read* 1.
108, 6 *from bottom*, *read the first part of this sentence as follows:* A straight bar projects from the hinder part of the plate *f*, and to this is attached a crank *g* in such a position that the end of its lower arm shall move vertically whenever the bar attached to *f* is moved horizontally.
109, 4, *for* ring, *twice repeated*, *read* swivel.
110, 23, *for the sentence* the weight *to* end of *g*, *substitute* the weight *l* on the spindle *i* balances the spiral *m*, the weight *o* on the crank balances the copper plate and horizontal bar, and another weight at the right hand end of the bar *g* (not shewn in the engraving), balances the weight of the wire.
144, 4, *after* entire *add* machine.
155, 11 *from bottom*, *for* shave *read* have.